NERL Research Abstract

EPA's National Exposure Research Laboratory
GPRA Goal 1 - Clean Air

Significant Research Findings

Modeling of Transport and Dispersion of Pesticide Spray Drift

Purpose

Application of pesticide substances to agricultural crops by a variety of spraying techniques results in a portion of the material drifting beyond the intended targeted areas and poses potential ecological and human risk. The purpose of this research is to develop and evaluate a spray drift model for implementing effective risk mitigation strategies. In developing this model it is necessary to have a better understanding of the factors that influence the transport, dispersion, and deposition of pesticide material originating from agricultural-based aerial, ground, and orchard spraying operations. The primary goals of this work have been the development of comprehensive data bases from which the near-field transport and fate of these toxic materials can be established and the development of modeling methodologies can be designed for effective risk mitigation strategies.

Research Approach

As part of a Cooperative Research and Development Agreement (CRADA) involving the EPA's National Exposure Research Laboratory, the U.S. Agricultural Research Service, and a consortium (Spray Drift Task Force) of about 40 pesticide chemical manufacturers, a number of major laboratory and field studies were performed to gather information on the drift and deposition of applied chemicals during a wide variety of application configurations and environmental conditions. This collaboration of expertise from government research labs and from private industry laboratories provides a unique opportunity for focused research that enhances the ability to provide effective estimates of environmental impacts from agricultural operations. Based on previous published works, it is believed that pesticide drift is primarily a function of the physical properties of the spray, the application equipment, and environmental conditions. Thus, these studies were designed to provide the necessary data for examining the sensitivity of drift to these factors. Because it is impossible to examine the full range of meteorological and application scenarios and due to the inherent variabilities in field data, the ultimate goal has been the development of modeling methodologies that form the framework for evaluating the potential risks of spraying operations and the potential effectiveness of proposed mitigation approaches.

Major Findings

The results of three major aerial field studies conducted in this project confirmed the findings in the literature that the drift and deposition of pesticide sprays is primarily influenced by the physical properties of the spray (particularly the drop size distribution released), the application equipment and setup (flow around aircraft and release height), and the meteorological scenario (particularly wind speed and associated stability). In the case of orchard airblast applications, again the spray properties and meteorological conditions were important but additionally the architecture of the orchard canopy was found to be a significant factor influencing off-target drift. Comparison of the AgDRIFT model (a primary product of this project) with the aerially-released deposition data shows minimal bias in the very near field and at greater distances a tendency to overpredict the observations by approximately a factor of two. Additionally, the model results and the field measurements respond similarly to variations in droplet size, wind speed, application height and other application variables. Finally, in comparing the models ability to estimate buffer zones (distance to deposition of a safe level), the model was in excellent agreement with the field results.

Research Collaboration and Publications

The AgDRIFT pesticide spray drift model and its associated spray drift databases resulted from the collaborative efforts of EPA's National Exposure Research Laboratory (Atmospheric Modeling Division and Ecosystems Research Division), EPA'a Office of Pesticide Programs, the U.S. Agricultural Research Service, and the pesticide industry's Spray Drift Task Force. Recent publications describing the model and its evaluation against field data follow.

Teske, M. E., Bird, S.L., Esterly, D.M., Curbishley, T.B., Ray, S.L., Perry, S.G. AgDRIFT: A model for estimating near-field spray drift from aerial applications. (In review). *Journal of the Society of Environmental Toxicology and Chemistry*. To be submitted.

Bird, S.L., Perry, S.G., Ray, S.L., Teske, M.E. Evaluation of the AgDRIFT aerial spray drift model. (In review). *Journal of the Society of Environmental Toxicology and Chemistry*. To be submitted.

Future Research

The AgDRIFT model currently contains a physics-based, mechanistic model for estimating pesticide spray drift from aerial applications. The current approaches for ground and orchard applications are statistically based on available field data. Future research involves the development of mechanistic approaches first for the ground (or tractor boom) based applications and then for the more complex orchard air-blast applications. Additionally, future work involves the development of climatologically based multiple application approaches to more adequately account for the cumulative impacts of spraying many applications throughout a month, season, or year.

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